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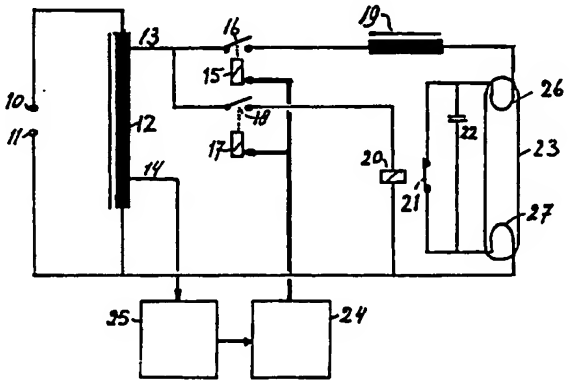
(54) **A circuit for igniting a gas discharge tube.**

(57) A gas discharge tube is preheated by means of the main voltage (10, 11) during a time which is related to the instantaneous value of that mains voltage, which value is measured with a measuring device (25). The measuring signal is fed to a microcomputer (24) which determines the pre-heating time in dependance on that signal and ignites the gas discharge tube with extraordinary reliability.



A circuit for igniting a gas discharge tube

This invention relates to a circuit for igniting a gas discharge tube having a filament at both ends, the circuit comprising a first switch by means of which one end of the first filament can be connected to one end of the second filament, a second switch and a coil via which the other end of the first filament can be connected to one terminal of an AC sypply, and a connection between the other end of the second filament and the other terminal of the AC supply.

Circuits of this kind are generally used for igniting gas discharge tubes, e.g. fluorescent tubes. In such cases the first switch is disposed in a closed glass envelope filled with an inert gas, while one of the switch contacts is in the form of a bimetallic member. On closing of a second switch disposed between the AC supply and the coil, a glow discharge will occur between the open contacts of the first switch, and will produce sufficient heat for the bimetallic contact of the first switch to close and a pre-heating current to flow through the filaments. On closing of the first switch contact, the glow discharge stops, as a result of which the bimetal can cool, so that after some time the first switch contact opens again. The resulting voltage pulse should ignite the fluorescent tube; if ignition does not occur, the process will restart. During the starting procedure, which usually lasts for some seconds, the fluorescent tube repeatedly lights before definitely striking.

In reproduction cameras fluorescent tubes are used as a light source for transmitting light through transparent originals. These tubes must all be started simultaneously and without flickering to enable the correct exposure to be carried out. The cameras must also be capable of being used under varying working conditions, e.g. with fluctuating mains voltages.

The known circuits do not satisfy these requirements. The object of the invention, therefore, is to provide a circuit for igniting a gas discharge tube without the said disadvantages.

According to the invention, this object is attained in a circuit of the kind referred to hereinbefore, in that the circuit also comprises

a microcomputer and a measuring device which is connected to the AC supply and whose output, which delivers a signal representative of the voltage of the AC supply, is connected to the microcomputer which in response to the representative signal successively delivers first and second control signals, and means which are connected to the microcomputer and which in response to the first control signals close the said switches for a time, the duration of which is inversely dependent on the voltage of the AC supply, and which then in response to the second control signals open the first switch.

Consequently, with different mains voltages the temperature of the filaments in the pre-heating phase, is always brought to a same value, at which instant starting occurs with extraordinary reliability.

The operation of the circuit according to the invention and other characteristics and advantages thereof will be apparent from the following description with reference to the accompanying drawings wherein:

Fig. 1 is a schematic representation of a circuit according to the invention,

Fig. 2 a is more detailed representation of a measuring device with a microcomputer,

Fig. 3 represents time diagrams of a control sequence, and

Fig. 4 represents time diagrams of another control sequence.

Gas discharge tube 23 (Fig. 1) comprises a first filament 26, one end of which can be connected via a first switch 21 to one end of a second filament 27, and a capacitor 22 connected in parallel across switch 21. Switch 21 is formed by a switch contact of relay 20. The other end of filament 26 is connected via a coil 19 to a second switch 16 formed by a switch contact of relay 15. The second switch 16 is connected to a tapping 13 of auto-transformer 12, which is connected to the mains voltage via terminals 10 and 11, while the other end of the second filament 27 of the gas discharge tube 23 is also connected to the mains voltage. Relay 20 is connected via a third contact 18 of relay 17 to tapping 13 of auto-transformer 12. A second tapping 14 is provided on auto-transformer 12 and is connected to a measuring device 25. The output of this measuring device 25 is connected to a microcomputer 24. The microcomputer 24 can deliver control signals which energise the relays 15 and 17.

The operation of the starter circuit shown in Fig. 1 will be explained by reference to the diagrams in Fig. 3. Diagrams 60, 61 en 62 illustrate the respective states of relays 15, 17 and 20, while diagram 63 represents the instantaneous value of the current through coil 19. At a time t1 (60), microcomputer 24 delivers a first control signal in response to which relay 15 is energized and switch 16 closed. Switch 21 is also closed in the non-energized state of relay 20. Consequently, a current will flow through and pre-heat the two filaments 26 and 27. In the manner to be indicated hereinafter, the microcomputer determines a first time during which switches 16 an 21 remain closed. At time t2 (61), the microcomputer then delivers a second control signal to relay 17, in response to which switch 18 closes and passes a current through relay 20. Since relay 20 is an AC relay to which an AC voltage is also fed from tapping 13, this relay will be energized only if the instantaneous current through said relay is sufficiently high (diagram 63). At time t3, at substantially maximum current through relay 20, this relay will be energized and open switch 21. At time t3 the instantaneous current through the coil 19 will also be high, so that a high voltage excitation occurs across the gas discharge tube 23 in the LC resonance circuit formed with capacitor 22, so that tube 23 ignites in combination with the exact pre-heating.

Fig. 2 is a more detailed representation of a measuring device 25 with a microcomputer 24. An AC voltage equivalent to approximately 10% of the mains voltage is available at tapping 14 of auto-transformer 12. This AC voltage is rectified in rectifier circuit 32 via a voltage divider formed by resistors 30 and 31, and fed to an 8-bit analog-digital converter 33. At the output of this A/D converter 33 there is obtained an 8-bit digital signal representative of the voltage of the AC supply. A/D converter 33 is also so constructed and controlled that at a mains voltage of 176 volts all the output bits are 0 and at a mains voltage of 240 volts all the output bits are 1. The A/D converter is thus able to divide the delivered AC voltage between the said limits, into 256 steps corresponding to 1/4-volt steps in the AC voltage.

Microcomputer 24 comprises a CPU 40, a memory 43, a control board 44, an input register 41 and an output register 42. Memory 43 contains a 256-location table, in which an associated pre-heating time is

established for each signal from the A/D converter (256 possibilities). The times are determined empirically, but are in each case inversely dependent on the voltage of the AC supply. For example, a pre-ignition time of 2.0 seconds is associated with a mains voltage of 240 volts, and a time of 3.7 seconds with 176 volts, while a pre-heating time of 3.0 seconds is established with a mains voltage of 196 volts. These pre-heating times depend on the type of gas discharge tube used.

The memory 43 also contains all the instructions required for the CPU 40 to carry out the necessary program steps required, for example, to energize the relays 15 and 17 for the specific times by reference to the times from the said table and signals from the control circuit 44 applied via drivers 45 and 46 respectively. To this end, by means of the representative signal available at the output of A/D converter 33, an appropriate address is selected in the said table, the contents thereof are read out and operation of the relays 15 and 17 is carried out accordingly by the control signals generated.

Fig. 4 represents the time diagrams of another control sequence, which will be explained in combination with Fig. 1. The diagrams 70, 71 and 72 illustrate the respective states of relays 15, 17 and 20 while diagram 73 represents the instantaneous value of the alternating current through coil 19.

At a time t1 microcomputer 24 delivers a first control signal by means of which relay 15 (diagram 70) is energized and switch 16 closed. Switch 21 is also closed in the non-energized state of relay 20. The pre-heating current will flow through the filaments 26 and 27 and pre-heat them. After a time, which is set in the table and is selected therefrom in accordance with the mains voltage, the microcomputer generates third control signals at time t2, in response to which relay 15 is no longer energized for a short period (t2 - t4) and second switch 16 is opened. This preset time of about 10 milliseconds is sufficient for the energy stored in the LC circuit to decrease to zero in the given circuit. The microcomputer then generates second control signals for relay 17 at time t4 (diagram 71), in response to which switch 18 closes and passes a current through relay 20. As described hereinbefore, gas discharge tube 23 is ignited at the maximum of the instantaneous current (diagrams 72 and 73), time t5.

The inclusion of a short time (t2 - t4) in which second switch 16

is opened ensures that the actual ignition of the tube 23 is carried out from a reproducible fixed state, so that ignition takes place with extraordinary reliability.

Of course the invention is not restricted to the embodiments described. For example, auto-transformer 12 can be dispensed with. The measuring device 25 can then be connected to the mains voltage either directly or via an opto-coupler. By providing a resistor between tapping 13 and switch 16 the measuring device, by measuring the voltage drop across this resistor, can derive a signal representative of the current through the tube. The times stored in the table can be related thereto so that also now an exact pre-heating can take place. Since the exact pre-heating times depend on the type of gas discharge tube, the table data concerning pre-heating time against mains voltage can be fixed in separate EPROM's for several types of tubes, so that the associated EPROM can also be changed over when a different tube is used. Of course it is possible to store data of frequently occurring tubes in different tables on various addresses in the memory and to make the associated table accessible by selection means on the control board.

CLAIMS

1. A circuit for igniting a gas discharge tube having a filament at both ends, the circuit comprising a first switch (21) by means of which one end of the first filament (26) can be connected to one end of the second filament (27), a second switch (16) and a coil (19) via which the other end of the first filament (26) can be connected to one terminal (10) of an AC supply, and a connection between the other end of the second filament (27) and the other terminal (11) of the AC supply, characterised in that the circuit als comprises a microcomputer (24) and a measuring device (25) which is connected to the AC supply and whose output, which delivers a signal representative of the voltage of the AC supply, is connected to the microcomputer (24) which in response to the representative signal successively delivers first and second control signal, and means which are connected to the microcomputer (24) and which in response to the first control signals close the said switches (16, 21) for a time, the duration of which is inversely dependent on the voltage of the AC supply, and which then in response to the second control signals open the first switch (21).

2. A circuit according to claim 1, characterised in that the microcomputer (24) generates third control signals in response to which the said means, after expiry of the said time and before opening of the first switch (21), open the second switch (16) and re-close it after a short preset time.

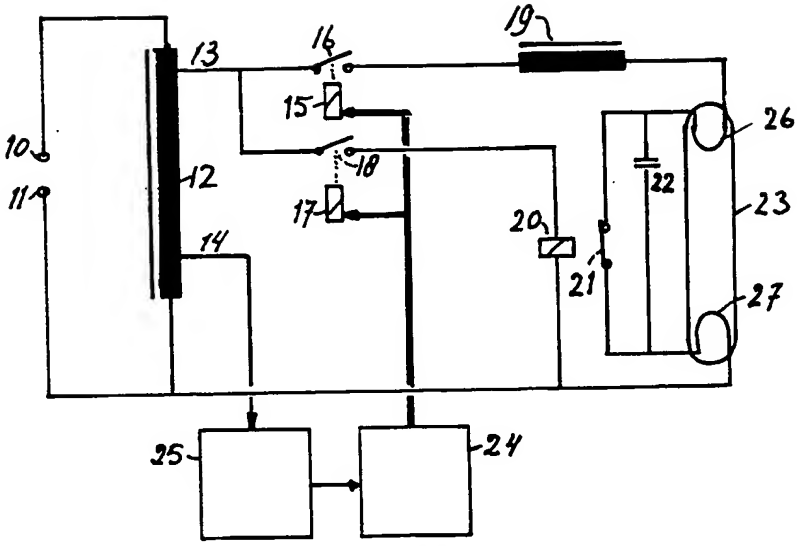


FIG. 1

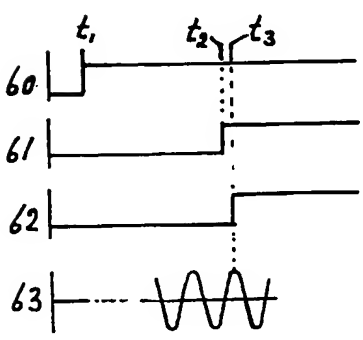


FIG. 3

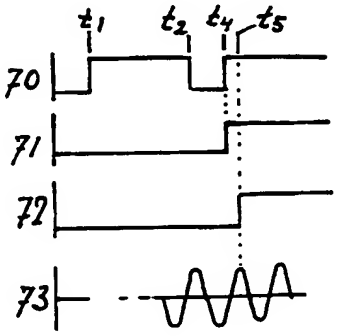


FIG. 4

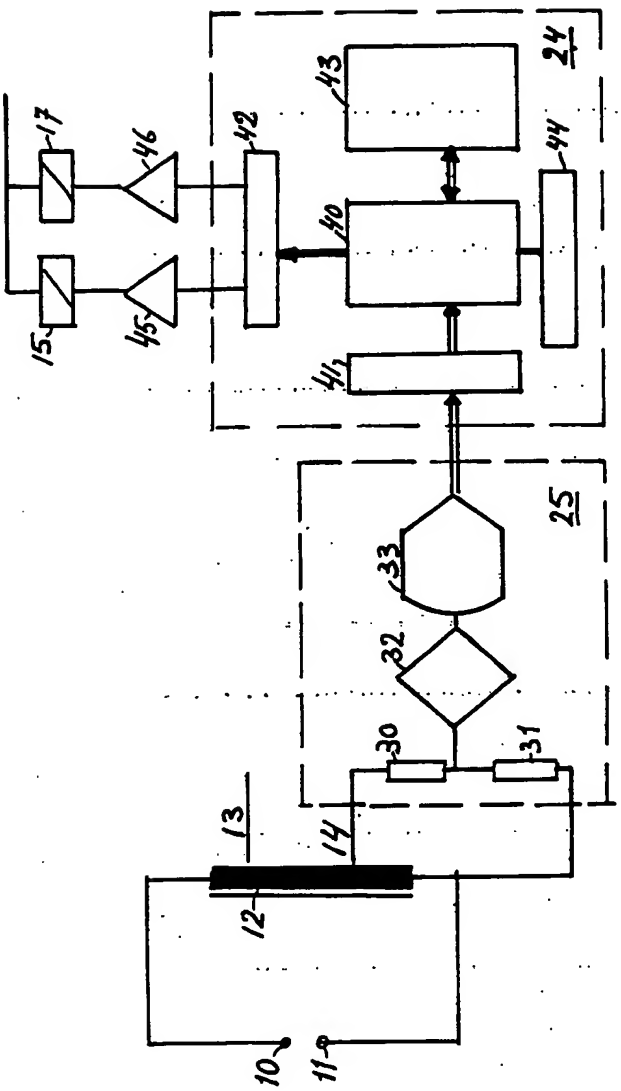


FIG. 2

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EUROPEAN SEARCH REPORT

Application number

EP 85 30 4088

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	WO-A-8 201 802 (KARIUS) * Page 4, line 16 - page 6, line 14 *	1	H 05 B 41/04

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 05 B 41/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19-09-1985	BERTIN M.H.J.

CATEGORY OF CITED DOCUMENTS

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